Delineating Aquatic Resources

June 2015

Introduction

- 5% of the lower 48 states are wetlands and other shallow aquatic habitats.
- However, abundance varies by region:
  - <1% of CA, NV, AZ, NM, UT, KS, MT, and WV
  - 28% of LA, 30% FL
  - 45% of AK

In the 1600s, over 220 million acres of wetlands are thought to have existed in the lower 48 states. Since then, over half the wetlands in the lower 48 have been drained and converted to other uses.

Stream density varies

- PA is 44,743.70 mi² and has 83,260 stream miles
- TX is 261,231.71mi² and has 191,228 stream miles
- UT is 82,169.62 mi² and has 85,916 stream miles

Why Delineate Aquatic Resources?

- Help to define the limits of Federal jurisdiction, in accordance with current law, regulations, and policy
- Determine the area affected by a project, as a first step in impact assessment, alternatives analysis, and mitigation

Relevant Federal Statutes

- Clean Water Act of 1972 and Amendments
  - Authorized EPA and the Corps to regulate the placement of fill in wetlands and other waters
- Food Security Act of 1985 and Amendments
  - Authorized NRCS to make wetland determinations under the Act's "Swampbuster" provisions

Some wetlands are easy to identify . . .

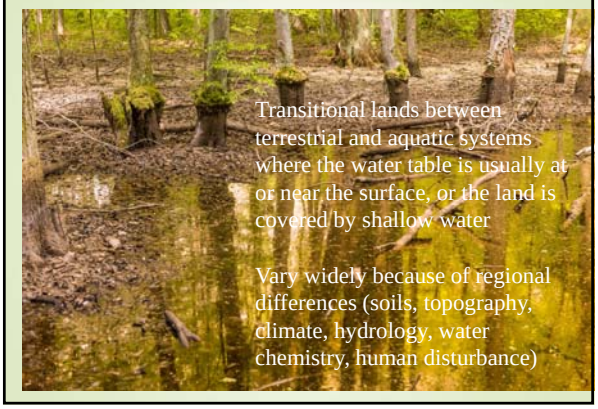
Are these Wetlands?


. . . others can be difficult and controversial.


Are these Streams?



WETLANDS



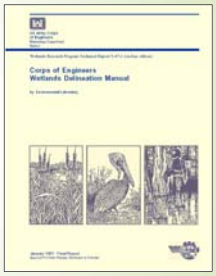
Transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water

Vary widely because of regional differences (soils, topography, climate, hydrology, water chemistry, human disturbance)

1987 Corps Manual

Corps of Engineers Wetlands Delineation Manual

http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx



ERDC/EL TR-07-24

Environmental Laboratory

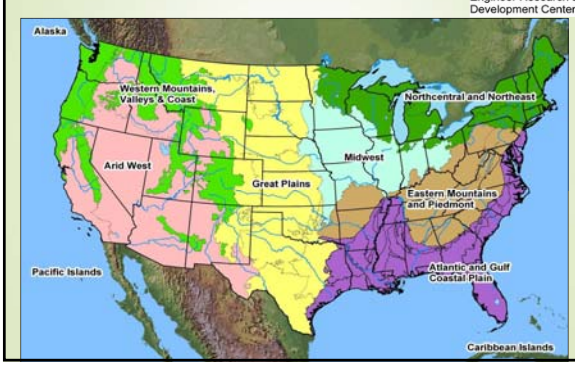
Regional Supplements to the Wetlands Delineation Manual

- Ten Regional Supplements
- Dozens of agency, academic, and private-sector experts involved
- Replace only certain portions of the 1987 Manual
- Goal is to identify all wetlands, without regard to current regulatory policy
- Current status and products:

http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx

Regional Supplements to the Wetlands Delineation Manual

US Army Corps of Engineers®
Engineer Research and Development Center



Wetland Definitions

- Corps/EPA definition - for Clean Water Act Section 404 purposes:
  - Areas that are ***inundated or saturated*** by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a ***prevalence of vegetation*** typically ***adapted for life in saturated soil conditions***.

Diagnostic Characteristics

- Wetland Hydrology
  - Evidence of ongoing wetland conditions
- Hydrophytic Vegetation
  - Dominated by species that are tolerant of prolonged inundation or soil saturation
- Hydric Soils
  - Exhibit characteristics that develop under permanent or periodic soil saturation

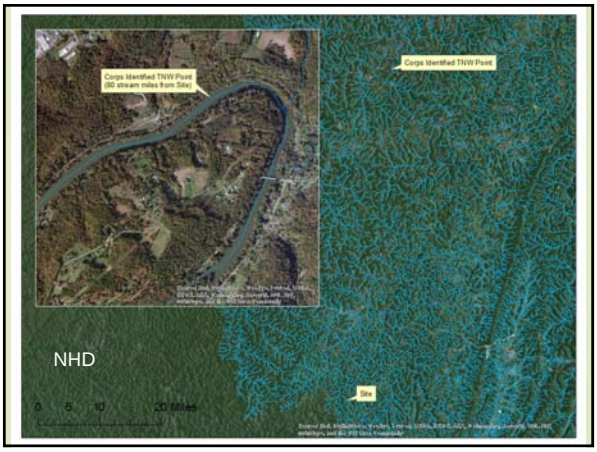
Normal Circumstances

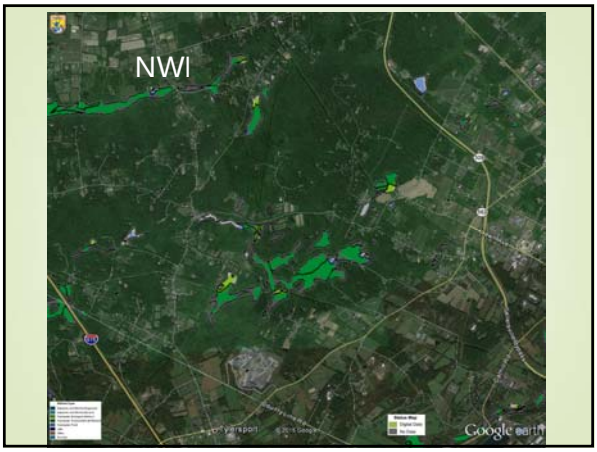
- The condition indicated by the soils and hydrology on a site, whether or not the vegetation has been altered or removed
- The long-term condition of the site, including any permitted or other legal alterations

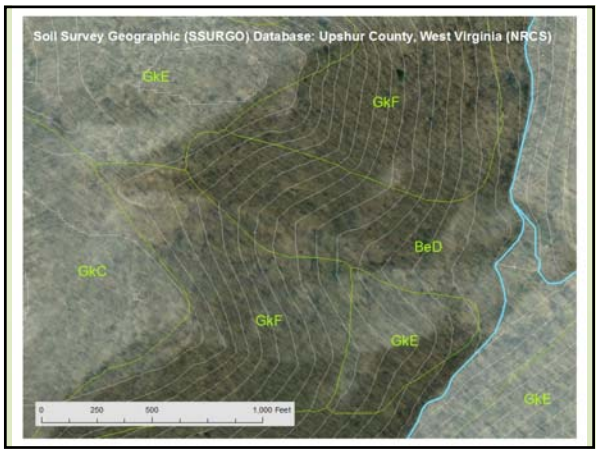
Desktop Review

Resources:

- National Hydrography Dataset (NHD)
- National Wetland Inventory (NWI)
- Soil maps
  - Web Soil Survey (websoilsurvey.sc.egov.usda.gov/)
  - GIS county soil layers (datagateway.nrcs.usda.gov/)
- Aerial photographs
- Topography
- Local/regional datasets

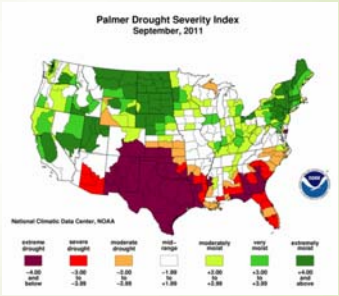






Climatological Data

- Precipitation data from the 48 hours preceding site visit (NOAA's Integrated Flood Warning System or rain gauge stations)
- Climate data in relation to long-term averages (Palmer Drought Index)



THREE PARAMETERS DEFINE A WETLAND ECOSYSTEM:

Vegetation

Soils

Hydrology

Hydrophytic Vegetation

- Dominance of vegetation adapted to saturated soil conditions
- Soggy or waterlogged soils leads to oxygen-deficient conditions
- Hydrophytes have developed adaptations for life in saturated soils, such as better physical support and better gas exchange

Adaptations

- Buttressed tree trunks
- Multiple trunks
- Swollen bases
- Hypertrophic lenticels
- Adventitious roots
- Shallow roots
- Aerenchyma
- Polymorphic leaves
- Floating leaves
- Aerial roots
- Pneumatophores

Buttressed Tree Trunks

Buttressed Tree Trunks (continued)

Harrison County Well Pad Site

Multiple Trunks

Caution – May occur as a result of sprouting after logging or browsing

Pneumatophores

Adventitious roots

Shallow roots

Caution – May be caused by erosion or near-surface bedrock

Aerenchyma

- Air channel in the roots of some plants
- Allows exchange of gases between the shoot and the root

Floating Leaves

Plant Indicator Status

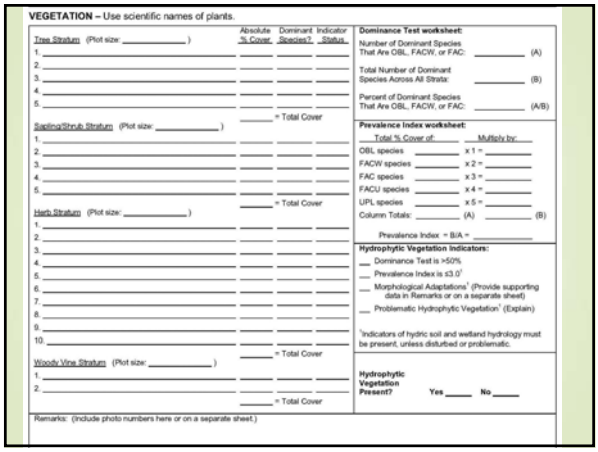
		Occurrence in Wetlands
Obligate Wetlands Plants (OBL)	Cattails Skunk cabbage Arrowhead Bulrush	>99%
Facultative Wetland Plants (FACW)	Sycamore Green ash Common/soft rush	67-99%
Facultative Plants (FAC)	Red maple Poison ivy Common greenbrier	34-66%
Facultative Upland Plants (FACU)	White pine Sugar maple Black cherry American beech	1-33%
Obligate Upland Plants (UPL)	Beebalm Indian grass Chickweed	<1%

Basic Rule: HYDROPHYTIC VEGETATION

More than 50% of the dominant species are OBL, FACW, or FAC

Definitions of Vegetation Strata

Tree	Woody plants ≥3.0 inches DBH, regardless of height
Sapling/Shrub	Woody plants ≥3.2 ft tall but <3.0 inches DBH
Herb	All nonwoody plants, and woody plants <3.2 ft tall
Woody Vine	Woody climbing plants ≥3.2 ft tall



VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: _____) — Absolute % Cover | Dominant Species? | Indicator Status
1. _____ 2. _____ 3. _____ 4. _____ 5. _____ = Total Cover

Sapling/Shrub Stratum (Plot size: _____)
1. _____ 2. _____ 3. _____ 4. _____ 5. _____ = Total Cover

Herb Stratum (Plot size: _____)
1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____ 9. _____ 10. _____ = Total Cover

Woody Vine Stratum (Plot size: _____)
1. _____ 2. _____ = Total Cover

Remarks: (Include photo numbers here or on a separate sheet.)

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)
Total Number of Dominant Species Across All Strata: _____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: _____ (A/B)

Prevalence Index worksheet:
Total % Cover of: _____ Multiply by: _____
OBL species _____ x 1 = _____
FACW species _____ x 2 = _____
FAC species _____ x 3 = _____
FACU species _____ x 4 = _____
UPL species _____ x 5 = _____
Column Totals: _____ (A) _____ (B)
Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:
__ Dominance Test is >50%
__ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No _____

National Wetland Plant List: Regular Update Process

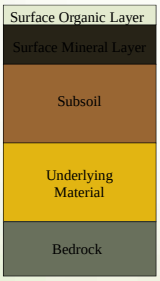
- Same Regional boundaries as used for the Delineation Manual supplements
- Regional Panels with representatives from EPA, Corps, FWS, and NRCS
- Expert Botanist Review for difficult species
- Major Update in 2012, annual there after as needed
- http://rsgisias.crrel.usace.army.mil/NWPL/
  - (Don't worry you can trust these sites – certificates don't match but it is the correct Corps address)

Soil

Natural body that occurs on the land surface, occupies space, and is characterized by one or both of the following:

- Horizons or layers, or . . .
- The ability to support rooted plants in a natural environment
  - Upper limit is air or shallow (>2.5 m) water
  - Lower limit is either bedrock or the limit of biological activity
  - Lower limit for classification set at 2 m (arbitrary)

Major Horizon Designations



O horizon

A Horizon

B Horizon

C Horizon

R Horizon

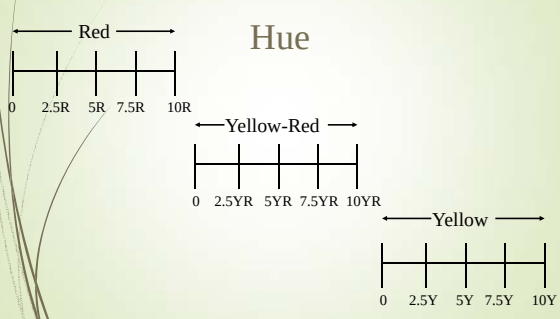
Key Soil Properties

Properties that are important to hydric soil development and recognition:

- Color
- Organic matter
- Texture
- Horizonation
- Drainage
- Permeability

Aspects of Soil Color

Hue



Aspects of Soil Color

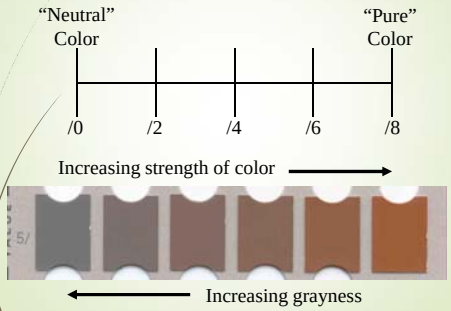
Value

The Lightness or Darkness of Color

- 10/0 - Pure White
- 5/0 - "Gray"
- 0/0 - Pure Black

Aspects of Soil Color

Chroma

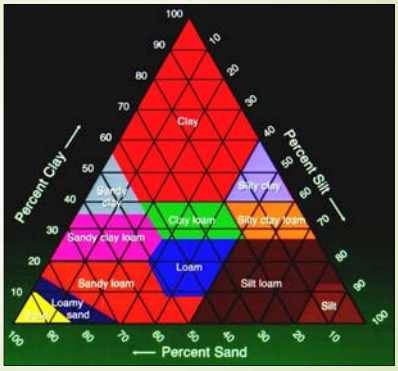


Soil Texture - Three Major Divisions

- All Soils
  - Use regardless of soil texture
  - Mostly surface layers of organic material
- Sandy Soils
- Loamy Soils

  - Use sandy indicators in sandy layers, loamy indicators in loamy layers

Soil Texture Triangle



Definition of a Hydric Soil

A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Local hydric soil lists should be consulted for background information before going into the field.



Development of Hydric Soils

Inundation or soil saturation

↓

Anaerobic conditions

↓

Chemical reduction (Fe, Mn, etc.)

↓

Distinctive soil characteristics


Hydromorphic Processes

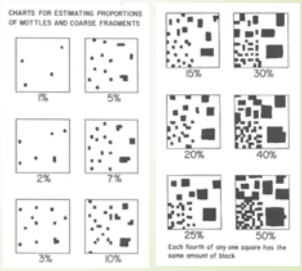
- Reduction of Iron and Manganese
  - Ferric (Fe^{3+}) -> Ferrous (Fe^{2+})
  - Manganic (Mn^{4+}) -> Manganous (Mn^{2+})
- Translocation
- Precipitation of Iron and Manganese

Hydromorphic Processes (cont'd)

- Accumulation of organic matter
  - Development of thick organic surfaces (peat or muck) or dark organic-rich mineral surface layers
- Reduction of sulfur
  - In the wettest sites containing sulfur compounds
  - SO_4^{2-} -> H_2S (hydrogen sulfide gas)

Color Patterns in Soils

- Optimum conditions
  - Natural light
  - Clear, sunny day
  - Midday
  - Light at right angles
  - Soil moist
- Matrix (predominant) color
- Mottle colors
- Mottle contrast and abundance

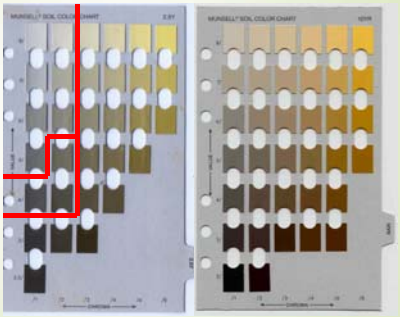


Version 7.0 and all info on hydric soils can be downloaded from the NRCS website:

http://soils.usda.gov/use/hydric/

F3. Depleted Matrix

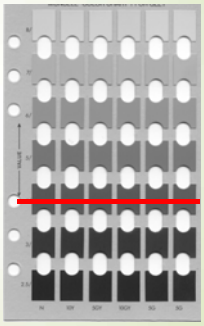
- Value 4 or more and chroma 1 or 2
- However, colors of value 4 & chroma 1 or 2 AND value 5 and chroma 2 must have redox concentrations



F3. Depleted Matrix (cont'd)

F2. Loamy Gleyed Matrix

- All colors found on the gleyed pages with value ≥ 4
- 60%+ of a layer starting within 12 in. of the soil surface



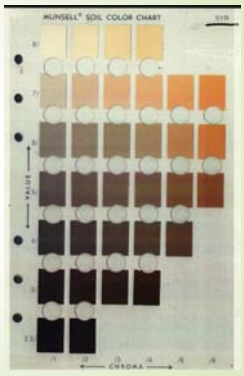
F2. Loamy Gleyed Matrix (cont'd)

A10. 2cm Muck

-A layer of muck 0.75 in. (2cm) or more thick

-Value of 3 or less AND chroma of 1 or less

-Starts within 6 in. (15 cm) of the soil surface



A10. 2cm Muck

-Commonly found in depressions that are ponded for several months each year

-Normally at the soil surface

Data Form – Soils

SOIL Sampling Point: _____

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ 5 cm Mucky Peat or Peat (S3)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ Coast Prairie Redox (A16)
- ___ Iron-Manganese Masses (F12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No _____

Remarks:

Criteria for Wetland Hydrology

Corps Manuals:

Area is inundated or saturated to the surface for at least 5% of the growing season in most years

Most wetland hydrology decisions are based on indicators

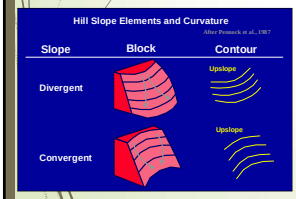


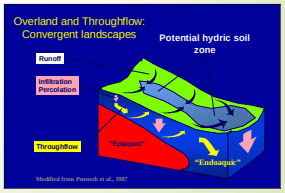
Sources of Water

- Direct Precipitation
- Headwater Flooding
- Backwater Flooding
- Tides
- Groundwater
- Combination of above

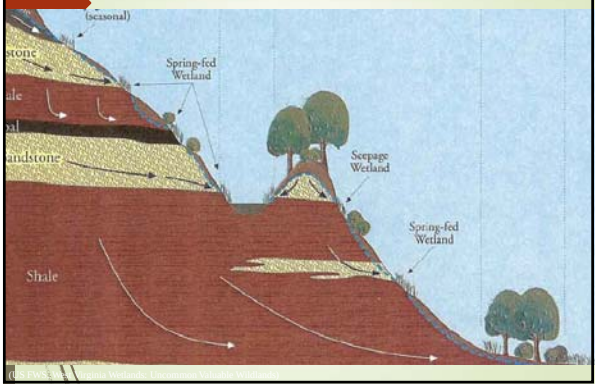
Landscape Position

- Critically influences water flow and soil formation
- Most wetlands, even groundwater seeps, are on some sort of concave surface





Wetland Landscape Positions



Hydrology Indicators

Presented in four groups

- Observation of surface water or saturated soil (*Group A*)
- Evidence of recent inundation (*Group B*)
- Evidence of recent soil saturation (*Group C*)
- Evidence from other site conditions or data (*Group D*)

Categorized as *Primary* or *Secondary*

- Primary – any one indicator is sufficient
- Secondary – two or more indicators are required

A1. Surface Water (primary indicator)

Caution – Be sure that normal environmental conditions exist at the site (especially precipitation)

A2. High Water Table (primary indicator)

A3. Saturation (primary indicator)

Must be associated with existing water table immediately below saturated zone

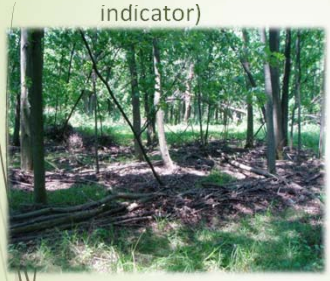
B1. Water Marks (primary indicator)

Caution – Ensure that a water mark is not from extreme flood event or an event that occurred outside the growing season

B2. Sediment Deposits (primary indicator)

Caution – Ensure that sediment deposits are not from extreme flood event or event that occurred outside the growing season

B3. Drift Deposits (primary indicator)



Caution – Ensure debris line is not from extreme flood event

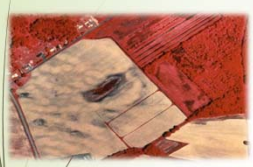
B4. Algal Mat or Crust (primary indicator)

- Occur on soils surface or low vegetation
- May crack and/or curl along edges

B5. Iron Deposits (primary indicator)

- Form in areas where reduced iron discharges with groundwater and oxidizes upon exposure to air
- Can be film on water surface
- Can be deposit on ground surface

B7. Inundation Visible on Aerial Imagery (primary indicator)



Caution:

- Ensure image was not taken during an extreme storm event
- Use multiple images when available
- Record date/frame/source of photo on data sheet

B9. Water Stained Leaves (primary indicator)

- Often occur in depressions
- Leaves maintain their black/gray color when dry

B13. Aquatic Fauna (primary indicator)

C1. Hydrogen Sulfide Odor (primary indicator)

- Indicator of hydrology and hydric soil
- Only occurs in extremely wet areas
- Often misidentified

C3. Oxidized Rhizospheres on Living Roots (primary indicator)

- MUST be present on living roots
- Rhizospheres must occupy >/= 2% of layer
- Cautions
  - Do not mistake color of root sheath and/or organic staining for iron plaque
  - rhizospheres on balls of hair-like roots easily mistaken for soft masses

B6. Surface Cracks (secondary indicator)

Caution – May occur in high clay content soils (Vertisols) in uplands due to high shrink/swell action

B10. Drainage Patterns (secondary indicator)

Usually not confined to a channel

B16. Moss Trim Lines (secondary indicator)

- Formed when water-intolerant mosses growing on tree trunks and other upright objects are killed by prolonged inundation

C8. Crawfish Burrows (secondary indicator)

- Usually found near streams, rivers and ponds
- Is one enough? Should be fairly abundant

D1. Stunted or Stressed Plants (secondary indicator)

- Can use natural and agricultural species
- **Caution** – Stunting can also be caused due to low fertility, excessive drainage, etc.

D2. Geomorphic Position (secondary indicator)

Area located in a depression, drainageway, concave position within a floodplain, at the toe of a slope, on the low-elevation fringe of a pond or other water body, or in an area where groundwater discharges

D4. Micro-topographic Relief (secondary indicator)

- Presence of microtopographic features that occur in areas of seasonal inundation or shallow water tables, such as hummocks
- "pit-and-mound" topography

What should I look at to interpret hydrology?

- Rainfall data and other water data
- Soil survey (stratigraphy, seasonal water table, soil drainage classes)
- Landscape position
- Soil profile and drainage classes
- Hydrologic features
- Hydrologic indicators--surface connections

Problematic Hydrology:

- Seasonal hydro-period
- Parent material
- Landscape position
- Recent deposition
- Newly created wetlands

Meteorological Considerations

To interpret hydrologic data or field observations, one must consider antecedent precipitation

- Did it rain immediately before the site visit?
- Has long-term precipitation been "normal"?

Role of the Technical Standard for Water-Table Monitoring

- To determine whether wetland hydrology is present on highly disturbed or problematic sites that lack wetland indicators
  - Not intended for routine use or to overrule an indicator-based determination on an undisturbed site
- Provides standards for the design, construction, and installation of water-table monitoring wells, and the collection and interpretation of data
  - http://el.erdc.usace.army.mil/wrap/pdf/tnwrap05-2.pdf

Data Form -- Hydrology

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water-Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ True Aquatic Plants (B14)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Gauge or Well Data (D9)
- __ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches): _____

Water Table Present? Yes ____ No ____ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches): _____

Wetland Hydrology Present? Yes ____ No ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Examples of Regional Indicators

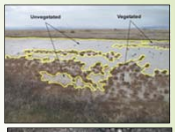
Using cryptogams (mosses, lichens, fungi) in hydrophytic vegetation decisions

Dry soils that appear hydric (e.g., gray parent materials)

Determining growing season (e.g., leaf-out)

Examples of Regional Indicators

Sand and gravel substrates



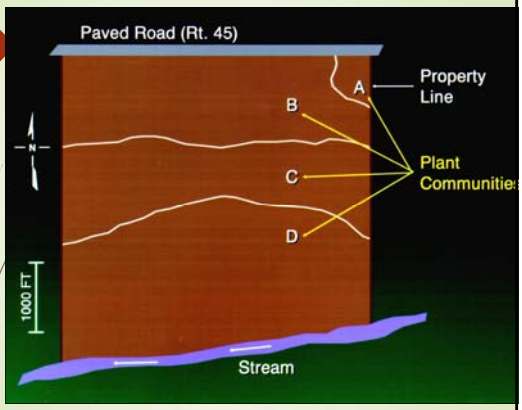
Sparse and patchy vegetation (e.g., playa edges and saline wetlands)

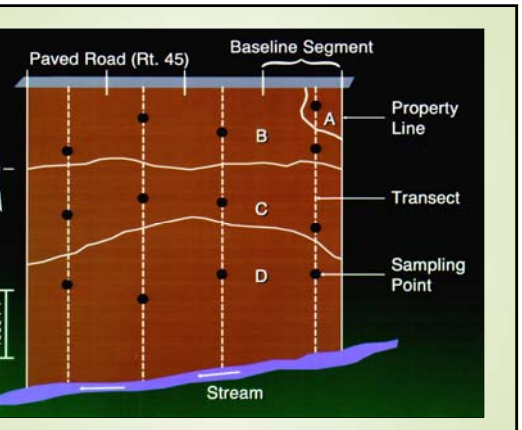
Identifying regional primary/secondary indicators of hydrology (e.g., surface soil cracks, crayfish burrows, macroinvertebrates, algae)

Seasonally frozen soils may develop wetland indicators but be well drained after they thaw

Atypical Wetland Situations

- Wetland indicators missing due to recent disturbances
  - Vegetation – mowing, herbicides, agriculture
  - Hydrology – ditching, draining, tiles, dams
  - Soils – disking, plowing
- Tools: Reference sites, soil mapping, pre-disturbance wetland maps and aerial imagery





STREAMS AND OTHER WATERS

Ordinary High Water Mark (OHWM)

Corps/EPA definition - for Clean Water Act Section 404 purposes:

- line on the shore established by the fluctuations of water and indicated by the physical characteristics such as:
  - clear, natural line impressed on the bank,
  - shelving,
  - changes in the character of soil,
  - destruction of terrestrial vegetation,
  - the presence of litter and debris, or
  - other appropriate means that consider the characteristics of the surrounding areas

OHWM Guidance

- Additional guidance provided by:
  - RGL 5-05 Ordinary High Water Mark Identification http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/GuidanceLetters.aspx
- Field guide for identification in the arid west (ERDC-CRREL-TR-08-12)
  - http://el.erdc.usace.army.mil/wrap/pubs.cfm?Topic=TechReport&Code=wrap
  - Western Mountains field guide coming soon

OHWM Delineation RGL 5-05

Physical characteristics that correspond to the line on the shore established by the fluctuations of water may vary depending on the type of water body and conditions of the area.

- This list is not exhaustive
- No "required" physical characteristics
- Generally identify two or more characteristics, unless there is particularly strong evidence of one

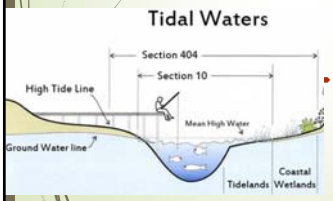
- Natural line impressed on the bank
- Shelving
- Changes in the character of soil
- Destruction of terrestrial vegetation
- Presence of litter and debris
- Wracking
- Vegetation matted down, bent, or absent
- Sediment sorting
- Leaf litter disturbed or washed away
- Scour
- Deposition
- Multiple observed flow events
- Bed and banks
- Water staining
- Change in plant community

Other Assessments

- May answer specific questions relevant to jurisdiction or resource function, structure or condition, for example:
  - Hydrogeomorphic (HGM) Guidebooks http://el.erdc.usace.army.mil/wetlands/hgmhp.html
  - Rapid Bioassessment Protocols (RBP) http://water.epa.gov/scitech/monitoring/rsl/bioassessment/index.cfm
  - Technical resources for streams http://water.epa.gov/lawsregs/guidance/wetlands/wetlandsmitigation_index.cfm#tec hncial
- Some methods have been developed to delineate the flow duration of streams using field indicators, for example:
  - North Carolina (state) http://portal.ncdenr.org/web/wq/swp/ws/401/waterresources/streamdeterminations
  - Ohio EPA (state)
  - Oregon (EPA, Corps, and state) http://yosemite.epa.gov/R10/ecocomm.nsf/wetlands/sdam

Tidal Definitions

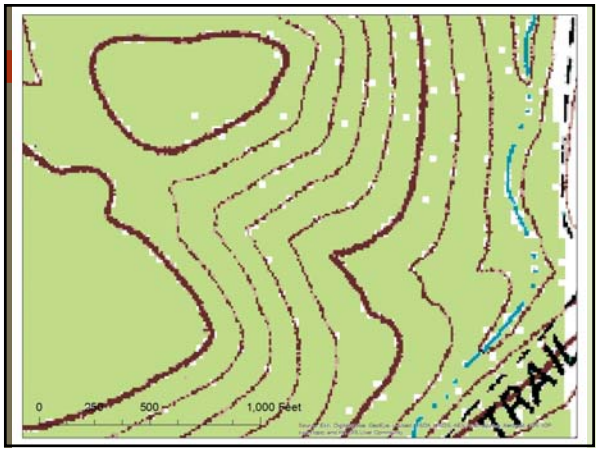
- Looking for the high tide line
  - The line of intersection of the land with the water's surface at the maximum height reached by a rising tide.



- The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide.
- The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges.

Case study

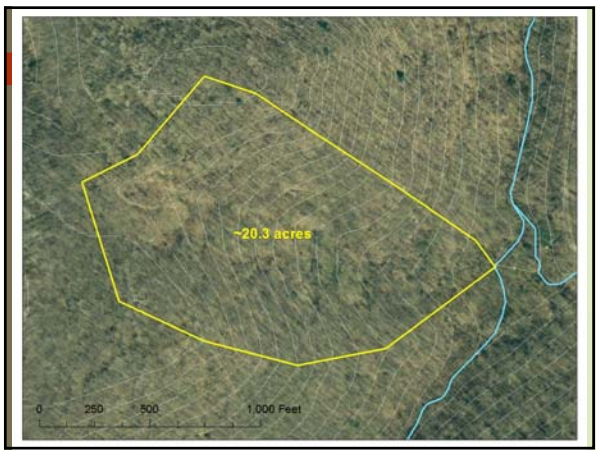

0 250 500 1,000 Feet


0 250 500 1,000 Feet
TRAIL


0 250 500 1,000 Feet


FCode Stream/River: Hydrographic Category = Intermittent
0 250 500 1,000 Feet


Local Resolution Streams - 1:4,800
0 250 500 1,000 Feet


~20.3 acres
0 250 500 1,000 Feet

Issue Paper-Indicator Tools for RPWs

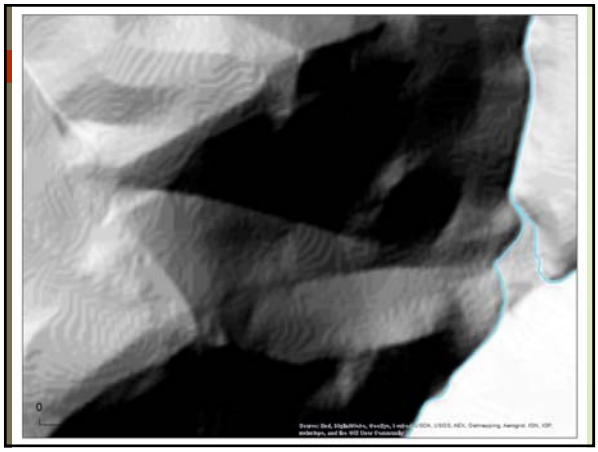
Recommendations for determining Relatively Permanent Waters (RPWs) in Headwater Streams in the Huntington and Pittsburgh Corps Districts

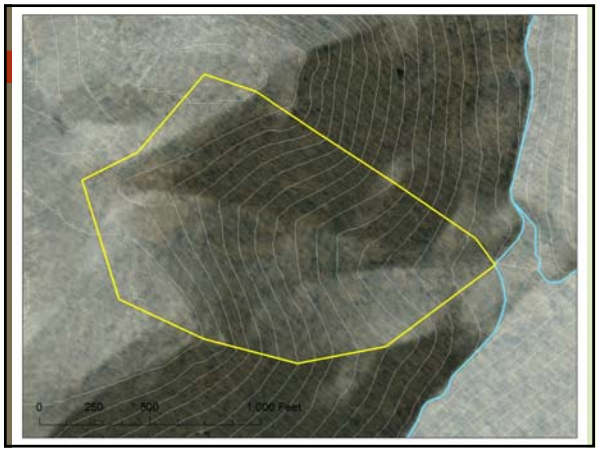
Greg Pond and Margaret Passmore, US EPA Region 3-EAID, Wheeling, WV 26003

July 19, 2007; *Finalized May 19, 2008*

Table 1. Mean of maximum catchment areas of Non-RPWs by location as interpreted from researcher's cutoffs for ephemeral/intermittent or ephemeral/perennial.

Location	n	Catchment Area (in acres)	Source
Robinson Forest (KY)	3	10.4	Fritz (unpub.)
Robinson Forest (KY)*	8	12.5*	Svec et al. 2005
E. Kentucky other (KY)*	5	19.8*	Svec et al. 2005
Coopers Rock SF (WV)	4	20.6**	EPA R3 (unpub.)
Upper Ohio Valley (WV/OH/PA)	19	5.3	B. Stout (unpub.)
Hoosier NF (IN)	1	6.1	Fritz (unpub.)
EAP-TNC (OH)	4	18.8	Fritz (unpub.)
Wayne NF (OH)	2	5.7	Fritz (unpub.)
WV MTM Region (WV)	36	14.5	Paybins 2003
NC Mountains (NC)	36	5.1	NCDWQ (unpub.)





Useful links

- Corps of Engineers Wetlands Delineation Manual
  - http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/reg_supp.aspx
- NRCS Wetlands and National Food Security Act Manual
  - http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/wetlands/?cid=nrcs143_010939
- Corps Headquarters, Regulatory Program
  - http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx
- EPA Wetlands Program
  - http://www.epa.gov/owow/wetlands/
- FWS Wetlands
  - http://www.fws.gov/wetlands/

Useful links, continued

- Vegetation:
  - National Wetland Plant List http://geo.usace.army.mil/wetland_plants/index.html
- Soils:
  - Hydric soils lists and Indicators http://soils.usda.gov/use/hydric/
  - http://www.statlab.iastate.edu/soils/nsdaf/
  - http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
- Hydrology:
  - WETS tables http://www.wcc.nrcs.usda.gov/climate/wetlands.html
- USGS Real-Time Water Data http://water.usgs.gov/nwis/rt
- National Climate Data Center
  - http://www.ncdc.noaa.gov
- USGS maps, photos, data
  - http://ask.usgs.gov/
  - http://topozone.com/
- NWI maps
  - http://www.nwi.fws.gov/

Questions?

Thanks to Brian Topping for many of the slides

Additional photo credits:

Eric Vance

Mike Mansolino